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Abstract

There has been constant friction between the U.S. and Japan on economic issues. After lengthy negotiations and threats of reprisal, Japan agreed to sell its Government Bonds through auctions that were open to foreign competition. This paper examines the bidding patterns in the Japanese Government Bond (JGB) auctions and it empirically tests the predictions of auction theory with JGB auction data. While the winning share of U.S. firms in 10-year JGB auction market went through ups and downs, their share in the 20-year market has increased steadily. We find that the winning shares of the U.S. investment banks are positively related to auction profits, whereas the winning shares of their Japanese counterparts show a negative association. We also find that the share of winnings of Japanese investment banks tend to be correlated with winnings of their compatriot investment banks but a similar relation is not found for US investment banks. We offer some possible explanations for these findings. The average profit in JGB auctions is not reliably different from zero, and the degree of competition and the level of uncertainty are found to be insignificant in determining auction profits.

1. Introduction

The JGB market is the second largest treasury bond market in the world, with an outstanding volume of $2 trillion (more than two-thirds of the U.S. Treasury market) and annual trading volume of $12 trillion in 1993.[1] Until recently, foreign firms were virtually excluded from participation in the primary market for Japanese Government Bonds (JGBs). The efforts to open up the primary market for JGB to foreign competition was not easy due to several legal and political obstacles. The negotiations were conducted at the government level, mostly between Japan and the U.S. and the U.K. They often involved threats of retaliation in the form of denying license to Japanese financial institutions in the U.S. and U.K. markets. A major stepping stone was laid when an inter-governmental working group known as the U.S.-Japan Yen-Dollar Committee issued its report in May 1984. One of the major mandates addressed in the report was the liberalization of access of foreign financial institutions to Japanese financial markets. Several changes followed this report, including the introduction of competitive auction mechanism to the primary market of JGBs.

Until recently, JGBs were sold to investors through a syndicate of underwriters. In syndicated offerings, a designated syndicate of underwriters buys newly issued bonds from the Ministry of Finance at a negotiated price and distributes these bonds to retail investors. The syndicate consisted of more than 800 banks, securities firms, and insurance companies, with only small shares sold to foreign financial institutions.[2] In response to strong pressure from the US, the Ministry of Finance eventually decided to issue portions of the 10-year JGBs through an

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[1]Bond Underwriters Association of Japan (1994).

[2]For example, in 1985, the foreign share in the syndicate totaled only less than 1%.

auction process, similar to that used for the U.S. Treasury auction. Under the new system, from April 1989 to September 1990, 40% of the new 10-year JGBs were issued through competitive discriminatory price auction and the remaining 60% were sold non-competitively to the syndicate members, at the quantity-weighted average of successful bids. From October 1990, again in response to continuing U.S. pressure, the auction portion was increased to 60%. The hybrid nature of combining auction and non-competitive allocation was a compromise between the U.S. position that the entire underwriting process should be based on an auction system and the Ministry's position that the syndicate underwriting system offers a more stable conduit for distributing JGB issues.[3]

This paper examines the extent to which U.S. firms were able to penetrate the Japanese market subsequent to this market opening. The performance of U.S. firms will shed some light on the usefulness of the aggressive U.S. posture in commerce negotiations with Japan. The next issue we examine is whether there are any discernible differences in the bidding skills of U.S. firms relative to their Japanese counterparts. One of the reasons why the Japanese government was reluctant to open up the JGB primary market was that it was concerned that U.S. firms, which dominate the U.S. Treasury auction market, may have superior skills in the auction market and hence may grow to eventually take away a large share of the JGB market from domestic firms. We directly evaluate this concern.

The lore in the US Treasury market is that the Japanese investment bank bids tend to be synchronized *i.e.*, the Japanese bidders either all bid aggressively, winning large shares in the auctions or their bids are all weak. Such bidding practices, if true, have important implications

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[3]See Semkow (1992).

for auction bidding strategies and outcomes. For instance, if bidding strategies were synchronized or correlated then the auctions bids would be more volatile than if all participants bid independently. We evaluate this hypothesis with data on the winnings of individual bidders in JGB auctions.

In a broader context, our analysis of the relative bidding skills and the bid synchronization hypothesis will help in understanding the characteristics of the participants in the primary market for Treasury securities. For example, if we find that one group of bidders possess superior bidding skills then it would imply that the bidders in this market are heterogeneous. In such a setting a realistic model of the auction process needs to allow for such heterogeneity while most models in the literature assume homogeneous bidders (e.g., Bikhchandani and Hwang (1989)). Similarly, if certain groups of bidders are found to bid in a synchronized manner, a realistic model of the auction process should allow for correlation in information signals received by the participants. These issues have not been addressed in the extant literature and hence we know very little about the composition of participants in the primary market for government bonds.

We also empirically test some predictions of auction theory with JGB auction data. In particular, we test the theoretical predictions of the association between auction profits and the level of competition in the auctions and the level of uncertainty. There is a growing literature that tests auction theory in the context of U.S. Treasury auctions. For example, Cammack (1991) investigates the T-bill auction in the U.S. and finds support for the theory. On the other hand, Jegadeesh (1993) examines the Treasury note and bond auctions and finds only weak support for the theory. Simon (1994) finds some consistent results with the theory for Treasury coupon

auctions. Nyborg and Sundaresan (1996) compare the profitability and bidding strategies in discriminatory and uniform price auctions. Away from the U.S. market, however, there is a significant paucity of literature on this subject, with the exception of Umlauf (1993) who examines the Mexican T-bill auctions. Our paper makes a contribution to fill this gap.

The rest of the paper is organized as follows. The next section describes the institutional background and the data. Section 3 examines the bids in JGB auctions and the distribution of winning bids across different classes of bidders. Section 4 presents the empirical tests and Section 5 concludes the paper.

2. Background and Data

JGBs are issued by the Ministry of Finance (MOF) in discriminatory price auctions. The 10-year JGB is the largest sector of government bonds, accounting for more than 80% of the amount outstanding. The auction schedule for 10-year JGBs is as follows. During the last 10 days of every month, MOF announces the coupon and the size of the next JGB issue, which are set after negotiations with the syndicate members. The issues range from 500 billion yen to one trillion yen in our sample period. The announcement of the actual size and the bond coupon occurs at 8:30 am on the auction date and bids are received from 11:30 am to 1:30 pm. Any syndicate member can bid up to 30% of the amount offered for auction. Although all members of the syndicates are eligible to submit bids, typically most of the bids are made by large banks and securities houses. MOF releases the auction results at 4:30 pm (2:30 pm after April 1993) on the auction date. On the next day, the remaining underwritten portion is allocated according to

preset shares at the quantity-weighted average price of successful bids.[4] An underwriting commission of 0.63 yen per 100 yen face value is paid by the government for both auctioned and non-competitively allocated portions. Since this can be considered a subsidy from the government, in our analysis below, we subtract this amount from the auction prices.

The actual issue usually occurs on the 20th of the calendar month after the auction and the payment is made on the issue date. There is no when-issued market in the pre-auction period similar to that in the U.S. but syndicate members can start trading the bonds on a when-issued basis after the auction date, although there is no formal market for such transactions.

The auction mechanism for 20-year JGBs is essentially the same as that for 10-year bonds. The main differences are: (1) they are issued much less frequently (2-4 times a year); (2)

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[4]Although the syndicate shares may be revised every year, they are generally fixed and do not directly reflect the results of previous auctions. The breakup as of April 1994 is as follows (source: Ministry of Finance, Japan):

Japanese Banks	65.08%
Foreign Banks	1.25%
Japanese Securities	23.11%
Foreign Securities	6.25%
Insurance	4.31%
Total	100.00%
Within securities firms (out of total):	
Daiwa	2.37%
Nikko	2.37%
Nomura	5.85%
Yamaichi	2.37%
Japanese Big 4 Total	12.96%
Goldman Sachs	0.60%
Merrill Lynch	0.60%
Morgan Stanley	0.60%
Salomon Brothers	1.51%
U.S. Big 4 Total	3.31%

they are sold entirely through auction (no syndicate) since September 1987; and (3) there is no underwriting commission paid to the bidders.

Secondary market trading of JGBs is concentrated on the over-the-counter transactions through *Nihon Sogo Shoken* (Japan Bond Trading Company). Roughly 95% of transaction are on the OTC. JGBs are also listed on the Tokyo Stock Exchange on the first trading day in the second month following the issue date, but the Exchange transactions are aimed at small investors. The characteristics of the secondary market are discussed in detail by Campbell and Hamao (1993) and Kikugawa and Singleton (1995).

We obtained data on auction results since auctions were introduced in April 1989 for 10-year JGBs, and since May 1991 for 20-year JGBs. Our sample period ends November 1994. The database contains average and minimum winning bids (in prices), coverage ratio (total bids tendered divided by amount sold in auction). Our database also contains the quantity of successful bids by each bidder (domestic and foreign), which is not publicly available for other countries. These data are collected by Sanyo Securities and are published in *Kinyu Facsimile Shinbun (Financial Facsimile News)*, which is a newsletter circulated among dealers. We also obtained daily secondary market prices of newly issued bonds, as well as seasoned bonds from Goldman Sachs. We use the last dealer quote of the day in our analysis.

3. JGB Auctions: Winning Bids

Table 1 presents the summary statistics for 10- and 20-year JGB auctions. The auctions are grouped by the relevant Japanese fiscal year which begins in April. Our sample consists of 68 auctions for 10-year JGBs and 14 auctions for 20-year JGBs. Of the 68 10-year JGB auctions,

49 are auctions of new bonds while 19 are reopenings. Of the 16 auctions of 20-year JGBs 14 were new issues and two were reopens.

A total of 54.4 trillion yen was raised with the issue of 10-year JGBs (both through auctions and direct issues to syndicates) during this sample period. The total issue of 20-year JGBs was considerably smaller and the total amount raised was 4.5 trillion yen.

The average coverage ratio in the 10-year JGB auctions is 4.07. The coverage ratio is nearly twice that for the 10-year note auctions in the U.S. where it is 2.16 (see Jegadeesh (1993)). The average price range for accepted bids is 0.13%, which is significantly smaller than the average range of 0.24% in the U.S. The lower range of accepted bids in Japan suggests that there is less price uncertainty in the Japanese market. This is somewhat surprising since there is no pre-auction when-issued market in Japan and hence unlike the U.S. market, participants in JGB auctions do not have the benefit of price discovery provided by the when-issued market. It appears, however, that any increased price uncertainty due to the absence of a when-issued market was more than offset by lower interest rate uncertainty in Japan and higher levels of auction participation, as indicated by the higher coverage ratio, resulting in lower dispersion of accepted bids.

Table 2 presents the average winning bids tendered by major participants in the auctions. In the 10-year JGB auctions, Japanese commercial banks tendered 29.67% of the winning bids in 1989. Their share declined to 15.16% in 1991 and eventually recovered to 24.86% in 1994. The U.S. firms started off strong winning 25.88% of the auction in 1989 but their share declined rapidly to 4.41% in 1992 before recovering to 13.85% in 1994. Much of the loss of the U.S. share is due to the diminished role played by Salomon Brothers in the post-1991 period. This

was the time that Salomon Brothers was embroiled in the Treasury Auction scandal in the U.S. (see Jegadeesh (1993)). The decline in the U.S. share may be related to this scandal and the eventual departure of key personnel from the Government Bond desk at Salomon Brothers in New York.

A bulk of the loss in share of Japanese banks and U.S. firms was captured by the Big Four Japanese investment banks (Daiwa, Nikko, Nomura and Yamaichi). Their share grew from 33.50% in 1989 to 73.33% in 1992 before declining to 46.64% in 1994. Foreign firms other than U.S. firms failed to make any significant inroads into the JGB auction market and their combined share hovered around one percent over the entire sample period.

It is interesting to compare the percentage winnings in competitive auctions with syndicate allocations set by the MOF. As stated earlier, only 60% of the 10-year JGB issues (40% until September 1990) is sold through auction while the remaining 40% is allocated to a syndicate at the quantity-weighted auction price. MOF decides on the share of each firm in the syndicate. The combined share of Japanese banks in the syndicate is 65% (see footnote 4) while they win on average only 21% of the auctioned portion of the issues. On the other hand, the combined share of foreign firms in the syndicate is only 8% while they win about 15% of the auctions. It appears that the syndicate system in the 10-year JGB issues serves to protect a certain share for Japanese banks that are probably not equipped to compete in the auctions, at the expense of foreign competition.

Table 2, Panel B presents the shares of major participants in the 20-year JGB auctions. In these auctions the share of Japanese commercial and investment banks declined over time. In 1991, the Japanese commercial and investment banks won 25.84% and 68.24% respectively but

their shares declined to 13.96% and 54.32% by 1994. Meanwhile, the share of the U.S. investment banks increased from a mere 5.70% in 1991 to 27.09% in 1994. A large part of gain in the U.S. share came from the increased share of Goldman Sachs. Here again, foreig firms other than U.S. firms failed to make a significant entry.[5]

It appears that the effort of the U.S. government to open the Japanese market paid of least in the short run in terms of enabling the U.S. firms to gain a significant share of the ma The U.S. firms will be able to retain this share and grow over time if they possess superior bidding skills. Many market participants in Japan, however, argue that early U.S. gains in t auction were due to aggressive bidding because of eagerness to establish a presence in the n even at a loss in the auction. In this case, U.S. market share in the auction may not be sustainable. Our empirical tests later in the paper evaluate these hypotheses.

4. Empirical Tests

We first test predictions of auction theory with JGB auction data. The specifics of t discriminatory price auction designed for JGB auctions has a number of complex features t have not been fully incorporated in any model in the literature. Our tests, therefore, rely on th predictions of first-price common value auctions where each bidder submits one bid for one u of the auctioned good.[6] The predictions of these models which do not critically depend on

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[5]It should be noted that Japanese commercial banks participate in the auction mainly ultimate investors, not as dealers. Banks owned 36% of JGBs outstanding as their investm 1992 (Bond Underwriters Association of Japan, 1994). Banks have also been allowed to se government bonds to their clients since 1985, but these transactions tend to be retail-oriente small in volume.

[6]In first-price auctions, the highest bidder gets the auctioned good at the price that h she bids.

auction design are tested here. The models that form the basis of our tests are Milgrom and Weber (1982), Englebrecht-Wiggins, Milgrom, and Weber (1983), and French and McCormick (1984).

In these models, two important factors that affect expected profit to the winner are the extent of dispersion of opinion among bidders and the number of bidders. Intuitively, the marginal probability of losing an auction by lowering the bid by a given amount decreases with an increase in the dispersion of bidders' pre-auction valuations. Therefore, auction theory predicts that higher dispersion of opinion on average results in lower bids and higher auction profits. The marginal probability of losing an auction by lowering the bid by a given amount increases with increasing levels of competition. Therefore, increased competition on average results in higher bids and lower profits. It should be noted that both these predictions obtain when there is a finite number of bidders. When the number of bidders is large (technically, tending to infinity) then the auction is characterized by perfect competition and the expected auction profit is zero. All bidders bid their expected values conditional on their winning the auction.

In addition to the above predictions, we also examine whether there is evidence of differential bidding skills between US and Japanese investment houses in the JGB auctions. Intuitively, if one class of bidders is better informed than the other class then the expected profit conditional on the informed bidder winning the auction will be higher than the expected profit conditional on the uninformed bidder winning the auction. Englebrecht-Wiggins *et al.* (1983) consider an auction for a common value good in a setting where one bidder is informed and the other is uninformed and their model yields predictions consistent with this intuition. The

concerns of the Japanese regulators suggests that the U.S. investment banks may systematically exhibit superior bidding skills, and we investigate whether the data support this notion.

We measure auction profit δ_t as follows:

$$\delta_t \equiv \Delta P_t^a - \Delta P_t^c$$

where ΔP_t^a is the difference between the average auction price and the when-issued bond price at the close of date t, and ΔP_t^c is the average percentage change in prices of three control bonds from the auction date to date t. The control bonds are bonds with maturities closest to the auction bonds.[7, 8] Since the control bonds are traded in the spot market, we adjust their returns for accrued coupon and carrying cost.[9] Since trading in the auction bonds is on a forward basis until the issue date (which is typically about 15 days from the auction date) no adjustments are required for carrying cost or accrued coupons. One may also consider ΔP_t^a as a measure of auction profit. This measure, however, contains the expected auction profit component as well as any price change due to unexpected changes in interest rates. Since price changes due to interest rate changes add noise to the profit estimates, we use δ as our measure of profit and control for price changes due to interest rate changes. Our results were qualitatively similar when we used one control bond rather than three bonds.

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[7]One may also consider ΔP_t^a as a measure of auction profit. This measure, however, contains the expected auction profit component as well as any price change due to unexpected changes in interest rates. Since price changes due to interest rate changes add noise to the profit estimates.

[8]Our results were qualitatively similar when we used one control bond rather than three bonds.

[9]We use the repo rate to compute carrying cost.

Table 3 presents the average auction profits for $t = 1$ to 5. We restrict the sample to new issues only and exclude reopenings.[10] For 10-year JGBs, the auction profits are not reliably different from zero. In comparison, Jegadeesh (1993) finds that for 10-year Treasury notes in the U.S., the average auction profit is 12 basis points, which is reliably positive. Nyborg and Sundaresan (1996), using transactions data, also find statistically significant but smaller positive profits. The lower expected auction profits in Japan are perhaps due to a combination of more intense competition in the auctions, as reflected in higher coverage ratios, and lower price uncertainty as reflected in the narrower price range. Table 3, Panel B presents the profits for 20-year JGB auctions. The average profit in this auction is also not reliably different from zero, as in the case of 10-year bonds.

In our tests of auction theory, we use the coverage ratio (*Ratio*) as the measure of competition. A high coverage ratio indicates intense competition and hence is expected to be associated with low auction profit. We use the difference between the average auction price and the lowest accepted bid (*Range*) as a measure of dispersion of pre-auction valuation.. To examine the relative skills of the U.S. and Japanese securities houses, we examine whether auction profits are related to the share of auction won by each group after controlling for the effects of *Ratio* and *Range*. Our focus here is to compare the behavior of directly competitive players in the JGB market, the four largest Japanese and U.S. investment banks.

The variables *Big4Japan* and *Big4US* used in the regression below are the fractions of the

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[10]We examined reopened issued separately. Since the prices of reopened bonds after the auction date are the same as the existing identical bonds, we measured the auction profits by comparing the average auction price and the price on the day after the auction. The resulting auction profits were also not significantly different from zero.

auction won by the four major Japanese investment banks (Daiwa, Nikko, Nomura, and Yamaichi) and four major U.S. investment banks (Goldman Sachs, Merrill Lynch, Morgan Stanley, and Salomon Brothers), respectively. If the Japanese firms have superior information, then the profits would on average be larger in auctions where they win a large fraction than in auctions where they win a small fraction.

We control for competitiveness and uncertainty in auction and fit the following two regressions:

$$\delta = a + a_1 Range + a_2 Ratio + a_3 Big4Japan + e \ ,$$

$$\delta = a + a_1 Range + a_2 Ratio + a_3 Big4US + e \ .$$

Table 4 presents the regression estimates and test statistics based on White's (1980) heteroskedasticity-consistent standard errors. The slope coefficients on both *Ratio* and *Range* are not reliably different from zero.[11] This suggests that the level of competition or the level of uncertainty do not play a significant role in determining auction profits. This is true for both 10- and 20-year JGB auctions (Panels A and B respectively). This result implies that the number of bidders is sufficiently large so that the auction market is approximated by the limit with infinite bidders. In this case, theory predicts that *ex-ante* expected profit will be driven down to zero and hence there will be no relation between *ex-post* profits and the variables *Range* and *Ratio*. Our finding that the average auction profit is not different from zero is also consistent with this

[11]Similar results were found when we used the pre-auction volatility of 10-year JGB futures prices in place of *Range*. Also, the regression slope coefficients on *Range* and *Ratio* were close to the reported values when the *Big4* variables were excluded from the regression specification.

explanation.

Turning to the slope coefficients on the country variables for the 10-year JGB auction, we find that the slope coefficient of *Big4Japan* is reliably negative. On the other hand, the slope coefficient on the variable *Big4US* is reliably positive. This indicates that the larger winnings of the Japanese firms in the auction are related to lower profits and the larger winnings of the U.S. firms are related to higher profits. For the 20-year JGB auctions the slope coefficient of *Big4Japan* is significantly negative. The slope coefficient of *Big4US* is on average positive but not reliably different from zero. The lack of significance of this slope coefficient is likely due to the limited sample size of 20-year JGB auction and the resulting lack of precision with which the parameters are estimated. Overall, the general result suggests that the U.S. firms have bidding skills superior to those of their Japanese counterparts.

To further analyze this point, we sort auctions into three groups by the percentage won by the Big 4 Japanese and U.S. firms, respectively. These results provide a more direct picture of the linkage between the auction profits and the winning share of the Japanese and the U.S. firms. Table 5 presents the average profits from one to five days after the auctions. For the 10-year JGB, when the Japanese Big 4 firms win a low proportion of the auction, the auction profits are positive (although not statistically significantly so). But when they win a high proportion of the auction, the profits are significantly negative and increasing over time. On the contrary, for the U.S. Big 4 firms, the profits are significantly negative when they win a low percentage of the auctioned bond. A similar pattern is observed in the 20-year JGB auctions. While significantly negative auction profits are associated with the high winning proportions by the Japanese Big 4 firms, positive profits are seen when U.S. Big 4 firms win high proportions.

One interpretation for this pattern is that the U.S. firms have the advantage in processing information concerning the value of the JGBs sold in the auctions. They win relatively more in auctions when the expected profits are high. The Japanese investment banks seem to be willing to bid even when the bonds they get in auctions are expected to generate losses.

Another interpretation of our evidence is also possible. The Japanese Big 4 firms may have private value associated with bidding in the auctions that is not readily evident when we consider only the profits in the auction. For example, the Japanese Big 4 firms may be in a better position to sell the JGBs to investors their institutional distribution network, especially to regional, relation-oriented clients. There have been several accounts in the press suggesting this point. For example, the trade publication *Nikkei Newsletter on Bond and Money* reports that "... aggressive bidding prices by Japanese houses are only justifiable by their ability to sell JGBs to their clients in combination with other attractive products such as new issues of convertible bonds that they underwrite (April 17, 1989)." Other anecdotal evidence suggests that some Japanese investment banks often receive orders for large bids from Japanese institutional investors who wish to be anonymous at the time of auctions. These are called "*Dairi Nyusatsu*" (proxy bids) and are submitted by investment banks at prices and quantities the clients specify. If the price risk of the auction bonds in the primary market is borne by clients (as indicated in these anecdotal stories) and if the market impact of purchasing the newly issued bonds in the secondary market is large, this "distribution advantage" would play a major role in the sales of JGBs, and hence influence the bidding strategy. In this case, for the major Japanese investment banks, their private valuation is not captured when we look only at auction profits. This would imply that it is not appropriate to characterize the JGB auction as common value good auction.

We can further speculate another possible explanation. It is well known that the financial system in Japan is rather tightly regulated. Regulation of financial markets by the government also implies protection of (domestic) financial institutions by the government. In the post-war period, there has been no bankruptcy of Japanese securities houses despite occasional financial distress for these firms. For example, a financial crisis in Yamaichi Securities in the 1960s was avoided by a low-interest rate loan made by the Bank of Japan. After the loss-compensation scandal by Japanese securities firms in 1991, some suggested deregulating the current fixed commission system on equity transactions. This was met by strong opposition from securities firms as well as the government out of concern about the adverse effect on revenues for the securities industry. Under these circumstances of "give and take" between the financial industry and the government, it is conceivable that domestic investment banks are obliged to purchase government bonds even at unfavorable prices in order to maintain a good long-term relationship with the government.

We next test the view that the Japanese investment bank bids tend to be synchronized *i.e.*, the Japanese bidders either all bid aggressively, winning large shares in the auctions or their bids are all weak. To develop our test of the synchronization hypothesis, consider a setting where there are three bidders A, B, and C with winning shares α, β, and γ. Under the hypothesis that all three bidders bid independently, the fraction of the auction won by A should not have any relation with how the rest of the auction is divided between B and C. On the other hand, if the winnings by A and B are correlated then large share for A (= α) will be associated with large share for B (= β) as a proportion of $\beta + \gamma$. To illustrate this point, assume that A, B, and C on average win one-third each in the auctions. In a particular auction assume that the winning

fraction of A is 40 percent. If all bids are independent then, conditioning on the information of A's winnings will not help in predicting how the remaining 60 percent of the auction is split between B and C; both B and C will on average win 50 percent each of the *remaining* portion of the auction. If the bids of A and B are positively correlated, however, then conditional on the information that A has won higher than his average share of the auction would imply that B will on average win more than 50 percent of the remaining portion of the auction. We measure this conditional correlation between the winnings of A and B by $corr(\alpha, \beta/(\beta+\gamma))$.[12]

Our tests of the synchronization hypothesis examines whether the winning of each Japanese or U.S. investment bank is correlated with combined winnings of their compatriot Japanese investment banks. To investigate, for example, whether the winnings of Nikko are correlated with that of the other Japanese investment banks, let α be the percentage winning of Nikko, β be that of the other three Japanese investment banks, and γ be that of all others (including four U.S. investment banks). Under the null hypothesis of uncorrelated winnings, $corr(\alpha, \beta/(\beta+\gamma)) = 0$.

Table 6 presents the correlations between the winnings of each of the four Japanese and U.S. investment banks with the fraction of the remaining portion of the auction won by rest of their Japanese or U.S. compatriot investment banks. For 10-year JGBauctions, this correlation is positive for all Japanese investment banks and the correlation is reliably different from zero for

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[12]The auction winnings of different bidders will typically be negatively correlated since the total should add up to one. Note, however, in this case we consider the correlation between the fraction of an auction won by A with the fraction of the *remaining* portion of the auction won by B.

Nikko, Nomura and Yamaichi.[13] For 20-year JGB auctions, we do not get precise estimates for correlation coefficients because of the small number of observations. In this case the correlation coefficients are reliably positive for two Japanese investment banks (Daiwa and Nomura) but they are not reliably different from zero for the other two Japanese investment banks. The correlation coefficients are not reliably different from zero for any of the American investment banks.

These results indicate that when one of the Japanese banks wins a high proportion in an auction, the others tend to win higher than average amounts of the remaining portion of the auction, which is consistent with the synchronization hypothesis. For the U.S. investment banks, however, none of correlation coefficient estimates is reliably different from zero. Therefore, the null hypothesis of independence of winnings across bidding firms cannot be rejected for the U.S. investment banks.

There are several reasons why the proportion of the auctions won by Japanese investment houses may be correlated. One possibility is that customer demand for JGBs are correlated across investment banks. As we discussed earlier, since these dealers place bids on behalf of their customers, any correlation in customer demands will lead to the investment banks themselves jointly bidding aggressively in certain auctions and not so aggressively in others. It is also possible that the Japanese investment banks observe similar information or apply similar models to analyze information. A less innocuous possibility is that these investment banks share information prior to auctions. Investigation of the relative merits of these explanations is likely

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[13]The standard error of the correlation coefficient is $\sqrt{(1 - \rho^2)/(n - 2)}$ where n is the number of observations and ρ is the correlation coefficient.

to be of broad interest but it is beyond the scope of this paper. Irrespective of the interpretation, our results indicate that any realistic model of Treasury auctions should allow for private information of bidders to be correlated.

5. Conclusions

Japan introduced an auction mechanism to sell government bonds after lengthy negotiations with the U.S. and the U.K. We find that the U.S. firms quickly gained a significant share of this market. While the U.S. share in the 10-year JGB auctions went through ups and downs, the U.S. share has steadily increased over time in the 20-year JGB market.

We examined the relation between auction profits and winning shares by the "Big 4" Japanese and U.S. investment banks. We find that the U.S. investment banks are more "profit sensitive" than their Japanese counterparts. We also find that the share of winnings of Japanese investment banks tend to be correlated with winnings of other compatriot investment banks but a similar relation is not found for U.S. investment banks. These findings indicate that the JGB auction market participants are heterogeneous and they bid based on correlated information. We do not find empirical support for predictions based on models of first price auction for common value goods. We find that the average auction profit is not reliably different from zero and we do not find any association between auction profits and measures of competition and dispersion of opinion among bidders.

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Table 1.
Japanese Government Bond Auctions - Ten- and Twenty-Year Bond Issues.

This table presents summary information of Japanese Government Bond (JGB) auctions for ten- and twenty-year bond issues. The sample period for the ten-year bond auctions is April 1989 to November 1994. From April 1989 to September 1990, 40% of each ten-year JGB issue was sold in the auction and the rest were allocated to syndicate members at the average auction price and from October 1990 60% of each JGB issue was sold in the auction. The sample period for the twenty-year JGB auctions is May 1991 to November 1994. All twenty-year JGB issues were sold in the auction.

Price Range is the difference between the weighted average auction price and the lowest accepted bid in the auction. Coverage ratio is the ratio of total bids in an auction to the amount sold in the competitive portion of the auction.

Panel A. Ten-Year Bond Issues

Fiscal Year	Number of Auctions	Amount Issued (Trillion Yen)	Price Range Min.	Price Range Av.	Price Range Max	Coverage Ratio Min.	Coverage Ratio Av.	Coverage Ratio Max
8904	12	7.2	0.04	0.16	0.32	2.82	4.15	7.13
9004	12	9.0	0.07	0.15	0.26	2.30	4.32	6.00
9104	12	9.6	0.03	0.07	0.12	2.43	4.03	6.08
9204	12	9.8	0.05	0.11	0.21	2.46	4.82	7.74
9304	12	10.8	0.05	0.15	0.38	1.44	4.20	6.88
9404	8	8.0	0.11	0.15	0.18	1.81	2.31	2.74
All Issues								
8904 - 9009	18	11.9	0.04	0.16	0.32	2.35	4.33	7.13
9010 - 9411	50	42.5	0.03	0.12	0.38	1.44	3.97	7.74
8904 - 9411	68	54.4	0.03	0.13	0.38	1.44	4.07	7.74
New Issues								
8904 - 9009	13	8.2	0.06	0.16	0.32	2.35	4.18	7.13
9010 - 9411	36	30.9	0.05	0.13	0.38	1.44	3.99	7.74
8904 - 9411	49	39.1	0.05	0.14	0.38	1.44	4.04	7.74
Reopens[†]								
8904 - 9009	5	3.7	0.04	0.13	0.19	3.81	4.71	5.67
9010 - 9411	14	11.6	0.03	0.11	0.33	1.68	3.94	6.56
8904 - 9411	19	15.3	0.03	0.11	0.33	1.68	4.14	6.56

Table 1 (contd.)

Panel B. Twenty-Year Bond Issues

Fiscal Year	Number of Auctions	Amount Issued (Trillion Yen)	Price Range			Coverage Ratio		
			Min.	Av.	Max	Min.	Av.	Max
91	3	0.94	0.08	0.16	0.24	1.62	2.43	3.58
92	4	1.33	0.04	0.09	0.14	2.66	2.89	3.32
93	4	1.32	0.05	0.15	0.23	2.21	2.88	3.63
94	3	0.94	0.11	0.16	0.22	2.02	2.37	2.63
All Issues								
9105 - 9411	14	4.53	0.04	0.14	0.24	1.62	2.68	3.63
New Issues								
9105 - 9411	12	3.93	0.04	0.14	0.24	1.62	2.70	3.63
Reopens								
9105 - 9411	2	0.60	0.15	0.15	0.16	2.47	2.57	2.66

† Reopens are auctions of bonds with the same coupon and maturity as a previously issued bond.

Table 2.
Japanese Government Bond Auctions - Distribution of Winning Bids.

This table presents the percentage of ten- and twenty-year Japanese Government Bonds (JGBs) won by each individual or class of bidders.

Panel A.Ten-Year Bond Issues

Fiscal Year	Number of Auctions	Japanese Banks	Japanese Inv. Banks (Big 4)*	Japanese Inv. Banks (Total)	U.S Total	Other Foreign
89	12	29.67	33.54	42.83	25.88	1.48
90	12	17.60	56.84	65.96	16.20	1.33
91	12	15.16	55.90	69.16	14.39	1.12
92	12	16.29	73.33	77.60	4.41	0.36
93	12	22.61	61.19	66.12	10.48	0.02
94	8	24.86	46.64	59.24	13.85	0.92
All Issues						
8904 - 9009	18	26.64	37.63	47.44	24.55	1.68
9010 - 9411	50	18.71	61.30	69.60	10.51	0.57
8904 - 9411	68	20.80	55.04	63.74	14.22	0.87
New Issues						
8904 - 9009	13	27.27	33.18	43.00	28.38	1.48
9010 - 9411	36	19.26	62.00	69.64	9.93	0.63
8904 - 9411	49	21.38	54.36	62.57	14.82	0.86
Reopens†						
8904 - 9009	5	25.00	49.20	59.00	14.60	2.20
9010 - 9411	14	17.29	59.50	69.50	12.00	0.43
8904 - 9411	19	19.32	56.79	66.74	12.68	0.89

Fiscal Year	Number of Auctions	Japanese Inv. Banks				U.S Inv. Banks			
		Daiwa	Nikko	Nomura	Yamaichi	Goldman Sachs	Merrill Lynch	Morgan Stanley	Sal. Bros.
89	12	9.18	4.34	14.27	5.75	1.40	0.90	2.04	19.58
90	12	14.71	11.60	19.59	10.94	3.31	0.56	1.14	10.32
91	12	11.81	15.88	16.72	11.48	7.95	1.27	0.85	2.98
92	12	18.20	22.50	21.75	10.87	2.32	0.39	1.54	0.00
93	12	10.59	19.14	14.83	16.62	3.99	0.55	1.26	4.20
94	8	9.63	12.03	14.97	10.00	3.80	1.87	2.22	2.71
All Issues									
8904 - 9009	18	10.26	5.12	15.74	6.52	2.44	0.89	1.93	17.52
9010 - 9411	50	13.33	17.71	17.65	12.61	4.28	0.86	1.30	3.03
8904 - 9411	68	12.51	14.38	17.14	11.00	3.80	0.87	1.47	6.86
New Issues									
8904 - 9009	13	9.58	4.09	13.64	5.87	2.37	0.54	2.29	21.26
9010 - 9411	36	15.37	17.99	17.51	11.13	3.59	0.78	1.30	3.04
8904 - 9411	49	13.84	14.30	16.49	9.74	3.27	0.71	1.57	7.87
Reopens									
8904 - 9009	5	12.00	7.80	21.20	8.20	2.60	1.80	1.00	7.80
9010 - 9411	14	8.07	17.00	18.00	16.43	6.07	1.07	1.29	3.00
8904 - 9411	19	9.11	14.58	18.84	14.26	5.16	1.26	1.21	4.26

Table 2 (contd.)

Panel B. Twenty-Year Bond Issues

Fiscal Year	Number of Auctions	Japanese Banks	Japanese Inv. Banks (Big 4)	Japanese Inv. Banks (Total)	U.S Total	Other Foreign
91	3	25.84	60.73	68.24	5.70	0.19
92	4	16.98	63.97	68.74	13.66	0.08
93	4	7.68	53.58	71.38	20.31	0.00
94	3	13.96	39.59	54.32	27.09	1.55
All Issues						
9105 - 9411	14	15.58	55.08	66.30	16.74	0.39
New Issues						
9105 - 9411	12	17.27	54.79	66.44	15.45	0.15
Reopens						
9105 - 9411	2	5.39	56.81	65.47	24.44	1.84

Fiscal Year	Number of Auctions	Japanese Inv. Banks				U.S Inv. Banks			
		Daiwa	Nikko	Nomura	Yamaichi	Goldman Sachs	Merrill Lynch	Morgan Stanley	Sal. Bros.
91	3	22.31	18.34	10.72	9.36	1.23	0.00	1.87	1.05
92	4	19.59	12.33	24.71	7.33	13.49	0.00	0.09	0.00
93	4	16.33	11.63	19.79	5.83	19.18	1.01	0.00	0.00
94	3	9.89	9.02	11.41	9.27	13.38	3.20	2.23	2.23
All Issues									
9105 - 9411	14	17.16	12.71	17.46	7.75	12.47	0.98	0.91	0.70
New Issues									
9105 - 9411	12	15.91	14.63	15.29	8.96	12.31	0.82	0.50	0.26
Reopens									
9105 - 9411	2	24.67	1.20	30.45	0.48	13.39	1.91	3.35	3.35

* Big4 - Japanese is the combined winnings of the following Japanese investment banks: Daiwa, Nikko, Nomura, and Yamaichi.

† Reopens are auctions of bonds with the same coupon and maturity as a previously issued bond.

Table 3.
Profits to winning bids in Japanese Government Bond Auctions - Ten- and Twenty-Year Bonds.

This table presents the average profits to winning bids in the ten- and twenty-year JGB auctions. ΔP_t^a is the percentage change in price of the auction bond (expressed in basis points) from the value-weighted average auction price to the secondary market price at the close of t days after the auction. ΔP_t^c is the average percentage change in the secondary market price of three seasoned bonds with maturity closest to the auction bond, adjusted for changes in accrued coupon and carrying costs.

Panel A. Ten-Year Bond Issues

Fiscal Year	Profit Measure	Number of Bonds	Days after auction				
			1	2	3	4	5
89	$\Delta P_t^a - \Delta P_t^c$	9	20.52	2.23	8.44	4.08	13.25
			(0.90)	(0.11)	(0.47)	(0.22)	(0.71)
90	$\Delta P_t^a - \Delta P_t^c$	8	1.37	−1.36	0.02	−0.84	1.49
			(0.19)	(−0.20)	(0.00)	(−0.09)	(0.13)
91	$\Delta P_t^a - \Delta P_t^c$	6	6.24	3.49	5.14	4.27	−5.69
			(1.41)	(0.74)	(1.07)	(0.82)	(−0.65)
92	$\Delta P_t^a - \Delta P_t^c$	9	−0.84	−0.27	−2.15	−4.25	−2.88
			(−0.18)	(−0.06)	(−0.44)	(−0.81)	(−0.51)
93	$\Delta P_t^a - \Delta P_t^c$	9	−11.70	−15.28	−16.03	−17.39	−19.98
			(−4.10)	(−4.66)	(−4.22)	(−4.87)	(−4.09)
94	$\Delta P_t^a - \Delta P_t^c$	7	0.62	0.11	1.61	4.84	6.43
			(0.05)	(0.01)	(0.11)	(0.34)	(0.46)
8904 - 9009	$\Delta P_t^a - \Delta P_t^c$	13	16.65	4.89	11.97	7.26	16.10
			(1.00)	(0.33)	(0.84)	(0.49)	(1.05)
9010 - 9411	$\Delta P_t^a - \Delta P_t^c$	36	−3.83	−4.66	−5.25	−5.35	−7.14
			(−1.17)	(−1.41)	(−1.43)	(−1.43)	(−1.76)
8904 - 9411	$\Delta P_t^a - \Delta P_t^c$	49	1.11	−2.27	−0.95	−2.19	−1.33
			(0.23)	(−0.50)	(−0.21)	(−0.47)	(−0.26)

Panel B. Twenty-Year Bond Issues

Fiscal Year	Profit Measure	Number of Bonds	Days after auction				
			1	2	3	4	5
91	$\Delta P_t^a - \Delta P_t^c$	3	−2.51	11.76	11.78	−0.99	−0.97
92	$\Delta P_t^a - \Delta P_t^c$	4	−8.17	−6.76	−8.18	−10.43	−19.09
93	$\Delta P_t^a - \Delta P_t^c$	3	3.38	−2.30	−3.78	−7.46	−3.98
94	$\Delta P_t^a - \Delta P_t^c$	2	4.11	11.15	11.33	1.64	−3.40
9105 - 9411	$\Delta P_t^a - \Delta P_t^c$	12	−2.36	1.97	1.16	−5.32	−8.17
			(−0.73)	(0.59)	(0.30)	(−1.33)	(−1.70)

Table 4
Association of Japanese Government Bond Auction Profits with Price Range, Coverage ratio and Winning Shares of Japanese and U.S. Investment Banks: Regression Analysis

This table reports the parameter estimates of the following regression:

$$\text{Profit} = a + a_1 \text{ Range} + a_2 \text{ Ratio} + a_3 \text{ Big4-Japan} \quad \text{and}$$
$$\text{Profit} = a + a_1 \text{ Range} + a_2 \text{ Ratio} + a_3 \text{ Big4-US},$$

where auction profit is defined as $\Delta P_t^a - \Delta P_t^c$; ΔP_t^a is the percentage change in price of the auction bond (expressed in basis points) from the value-weighted average auction price to the secondary market price at the close of t days after the auction. ΔP_t^c is the average percentage change in the secondary market price of three seasoned bonds with the maturity closest to the auction bond. See Table 1 for definition of "Ratio" and "Range." "Big-4 Japan" is the fraction of the auction won by the following four Japanese investment banks: Daiwa, Nikko, Nomura and Yamaichi; "Big-4 U.S" is the fraction of the auction won by the following four U.S. investment banks: Goldman Sachs, Merrill Lynch, Morgan Stanley and Salomon Brothers. t-statistics are reported in parentheses.

Panel A. Ten-Year Bond Issues (49 auctions)

t	Intercept	Range	Ratio	Big4 Japan	Big4 US
1	0.2250	−0.5570	0.0235	−0.4454	−−
	(1.03)	(−0.79)	(0.73)	(−2.14)	−−
1	−0.0499	−0.6456	0.0084	−−	0.7483
	(−0.26)	(−0.91)	(0.27)	−−	(2.31)
2	0.2736	−0.4118	−0.0106	−0.3644	−−
	(1.23)	(−0.56)	(−0.32)	(−1.72)	−−
2	0.0411	−0.4562	−0.0215	−−	0.6208
	(0.21)	(−0.63)	(−0.68)	−−	(1.87)
3	0.3426	−0.2517	−0.0103	−0.5097	−−
	(1.56)	(−0.35)	(−0.32)	(−2.44)	−−
3	0.0272	−0.2338	−0.0259	−−	0.7275
	(0.14)	(−0.32)	(−0.81)	−−	(2.19)
4	0.3410	−0.2659	−0.0202	−0.4534	−−
	(1.51)	(−0.36)	(−0.61)	(−2.12)	−−
4	0.0705	−0.1675	−0.0344	−−	0.5021
	(0.35)	(−0.22)	(−1.04)	−−	(1.46)
5	0.4136	−0.1655	−0.0222	−0.5815	−−
	(1.74)	(−0.21)	(−0.64)	(−2.57)	−−
5	0.0629	−0.0703	−0.0404	−−	0.6984
	(0.29)	(−0.09)	(−1.15)	−−	(1.91)

Table 4 (contd.)

Panel B. Twenty-Year Bond Issues (12 auctions)

t	Intercept	Range	Ratio	Big4 Japanese	Big4 US
1	−0.1140	0.1998	0.0807	−0.2707	−−
	(−0.62)	(0.44)	(1.62)	(−2.61)	−−
1	−0.2267	0.0080	0.0615	−−	0.2651
	(−1.09)	(0.01)	(1.07)	−−	(1.47)
2	0.2609	−0.0376	−0.0524	−0.1731	−−
	(1.13)	(−0.07)	(−0.85)	(−1.34)	−−
2	0.1681	0.0885	−0.0552	−−	−0.0821
	(0.72)	(0.15)	(−0.84)	−−	(−0.39)
3	0.1652	0.4495	−0.0394	−0.1980	−−
	(0.64)	(0.75)	(−0.57)	(−1.36)	−−
3	0.0590	0.5863	−0.0428	−−	−0.0826
	(0.22)	(0.89)	(−0.58)	−−	(−0.34)
4	−0.1717	0.3417	0.0890	−0.3065	−−
	(−0.68)	(0.58)	(1.31)	(−2.15)	−−
4	−0.3402	0.2931	0.0775	−−	0.2746
	(−1.25)	(0.44)	(1.02)	−−	(1.12)
5	−0.0861	0.6556	0.0526	−0.4137	−−
	(−0.30)	(0.97)	(0.68)	(−2.53)	−−
5	−0.3141	0.5470	0.0361	−−	0.4371
	(−1.00)	(0.70)	(0.41)	−−	(1.53)

Table 5
Auction Profits and Winning Shares of Japanese and U.S. Investment Banks in Japanese Government Bond Auctions.

This table presents the average profits in ten- and twenty-year JGB auction within three groups sorted by the percentage of auction won by Big-4 Japan and also within three groups sorted based on the percentage of auction won by Big-4 US. t statistics are reported in parentheses.

Panel A. Ten-Year Bond Issues (49 auctions)

	Percentage	Auction Profit				
	Won	1	2	3	4	5
Sort by Big4-Japan						
Low	26.12	4.96	6.63	12.05	9.43	15.01
		(0.45)	(0.58)	(1.10)	(0.84)	(1.32)
Medium	58.94	6.51	−0.54	0.77	0.14	2.51
		(1.13)	(−0.12)	(0.18)	(0.03)	(0.43)
High	77.44	−11.62	−12.92	−15.66	−16.15	−21.51
		(−2.54)	(−2.77)	(−2.93)	(−3.00)	(−4.18)
High-Low	51.31	−16.58	−19.55	−27.71	−25.58	−36.52
		(−1.40)	(−1.59)	(−2.27)	(−2.06)	(−2.92)
Sort by Big4-U.S						
Low	0.38	−7.37	−8.63	−9.56	−9.70	−14.01
		(−2.49)	(−2.81)	(−2.85)	(−2.74)	(−3.27)
Medium	9.94	−1.44	−1.69	0.12	2.06	4.09
		(−0.23)	(−0.27)	(0.01)	(0.25)	(0.43)
High	30.69	8.52	3.50	6.60	1.06	5.94
		(0.79)	(0.31)	(0.63)	(0.10)	(0.57)
High−Low	30.31	15.89	12.13	16.16	10.76	19.95
		(1.41)	(1.02)	(1.48)	(0.96)	(1.78)

Table 5 (contd.)

Panel B. Twenty-Year Bond Issues (12 auctions)

	% of Auction	Auction Profit 1	2	3	4	5
Sort by Big4-Japan						
Low	29.89	1.75	2.55	2.56	2.58	0.11
		(0.72)	(0.76)	(0.38)	(0.38)	(0.01)
Medium	52.14	0.16	12.02	12.18	−3.64	−4.69
		(0.03)	(2.83)	(2.92)	(−0.57)	(−0.85)
High	82.34	−8.01	−8.68	−11.25	−14.90	−19.93
		(−1.39)	(−2.12)	(−4.06)	(−3.58)	(−2.59)
High − Low	52.45	−9.76	−11.23	−13.81	−17.48	−20.04
		(−1.56)	(−2.11)	(−1.90)	(−2.21)	(−1.80)
Sort by Big4-U.S						
Low	0.74	−4.94	−0.16	−2.57	−8.65	−16.02
		(−0.69)	(−0.03)	(−0.39)	(−1.11)	(−1.66)
Medium	9.32	−2.91	3.51	3.50	−9.88	−8.59
		(−0.66)	(0.52)	(0.52)	(−2.69)	(−2.02)
High	31.61	1.75	2.55	2.56	2.58	0.11
		(0.72)	(0.76)	(0.38)	(0.38)	(0.01)
High − Low	30.87	6.69	2.71	5.13	11.24	16.13
		(0.89)	(0.38)	(0.55)	(1.09)	(1.28)

Table 6
Correlation between Winning Shares of Japanese and U.S. Investment Banks in Ten-Year Japanese Government Bond Auctions.

This table presents the correlation between winnings of each of the four Japanese and US investment banks with the fraction of the remaining portion of the auction won by rest of their compatriot investment banks. t statistics are reported in parentheses. The sample comprises all new bond auction in the April 1989 to November 1994 period.

Panel A. Ten-Year Bond Issues (49 auctions)

Big4-Japan		Big4-US	
Investment Bank	Correlation	Investment Bank	Correlation
Daiwa	0.14	Goldman Sachs	−0.08
	(0.99)		(−0.57)
Nikko	0.49	Merrill Lynch	0.10
	(3.81)		(0.67)
Nomura	0.24	Morgan Stanley	0.04
	(1.67)		(0.26)
Yamaichi	0.37	Salomon Brothers	0.02
	(0.69)		(0.16)

Panel B. Twenty-Year Bond Issues (12 auctions)

Big4-Japan		Big4-US	
Investment Bank	Correlation	Investment Bank	Correlation
Daiwa	0.57	Goldman Sachs	0.085
	(2.20)		(0.27)
Nikko	-0.10	Merrill Lynch	0.18
	(-0.31)		(0.57)
Nomura	0.55	Morgan Stanley	−0.33
	(2.09)		(1.09)
Yamaichi	-0.30	Salomon Brothers	−0.24
	(1.00)		(−0.78)